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UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

Agenda Item: D.1.3

Portugal

CERAMIC MATERIALS AND PRODUCTS : TECHNIQUES OF SCIENTIFIC AND TECHNOLOGICAL CONTROL

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CERAMIC MATERIALS AND PRODUCTS -
- TECHNIQUES OF SCIENTIFIC AND TECHNOLOGICAL CONTROL

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1. INVESTIGATIONS FOR THE IMPROVEMENT OF THE TECHNOLOGICAL AND INDUSTRIAL APPLICATIONS OF A COUNTRY'S NATURAL RESOURCES.

Primitive peoples developped ways and means for utilizing the natural resources of their countries, each succeeding generation improving on the processes, as best as they could, not only to save labour, but to better the products. Taking any particular region of the world at its earliest times one finds the so-called traditional industries as the only existing ones, being slowly but steadily refined. During that region's early history few new industries can be seen to appear.

Later, as improved means of communication and transportation began making this a smaller world, in every country most secrets ceased to be. Then if some untapped natural resource still existed, it gave rise to new, borrowed industries, with few exceptions. Depending on how well a people could "take-in" a borrowed industry, it became with time a semi-traditional industry in that particular region.

A ceramic product and its main raw material, viz. porcelain and kaolin, can be used to illustrate this point. For many centuries, the Chinese were the only people utilizing their natural resources of kaolin for making porcelain and it was not until a couple of centuries back that European countries gained knowledge on porcelain manufacture. And then, this foreign or borrowed industry took such hold in some countries, especially France and Germany, as to become a semi-traditional industry there.

The transfer of knowledge is never a one-way affair and the beer industry - a traditional one in Germany - found its way into China. However this is still a "foreign" industry there and it may take many a year before it changes into semi-traditionalism. There are human factors that oppose the settling in of the industry and cannot be neglected. A successful transfer, for example, was that of a traditional industry from countries such as Portugal and France to South Africa, who borrowed and set-up a wine industry, already falling into semi-traditionalism there. These industries have one thing in common and that is the fact that it takes not only time, but the people's outlook towards them to really make a successful transfer.

As opposed to these, one finds another group of industries, which one can call the "universal" ones, e.g. the heavy chemicals, cements, petroleum products, pharmaceuticals, etc., which were born more out of science and technology than tradition, and although they must exist in any industrialised country to form the industrial bone-structure that cannot be given by the other types of industry considered above, they can hardly ever become

part of a nation's soul, so to speak.

These points are briefly summarized in table 1, and should be taken into consideration when planning the industrial reorganization of a country.

The establishment of universal industries is an easy process nowa-days, it is only the keeping up to world progress that must be internally assured. The borrowing of non-universal industries to suit a country's natural resources and her peoples nature is a more difficult task, with problems other than scientific and technological to be considered for successful transfer and adaptation, and while considering it, a country must concentrate most of her industrial research upon traditional industries, where the assistance is greatest to make use of scientific advances.

Although in Portugal there exist industries of the four types mentioned in table 1, the National Institute for Industrial Research, on setting forth to investigate the industrial applications of the Nation's natural resources - either animal, vegetable or mineral - concentrated its initial efforts on the most important traditional (and semi-traditional)industries.

Obviously enough, though, facilities were provided first for all and every industry by the installation of well- equipped and staffed analytical laboratories covering the fields of organic and inorganic chemistry ; bio-, electro-, and physical-chemistry; the establishment of a general scientific library and documentation centre; the setting up of an industrial economics centre; a bureau of industrial planning and productivity techniques; a metallurgy and corrosion nucleus; and so on.

Initial research centred on industries such as fishing and canned fish; timber and resinous products; cork; glass; ceramics; with already projected studies on wines, textiles, fruit and its canned-products; leather , sugar, etc.

It is some of the initial work done in setting up a ceramics unit that will be described.

2. PLAN OF ACTION AND FACILITIES AVAILABLE IN THE FIELD OF CERAMICS

a) Enquiries and contacts with the industry

Since the Ceramic Industry includes distinctive sub-industries, viz. porcelain, stoneware and whiteware, ordinary pottery and faiance,heavy clay products and refractories, any research program has to include as many sub-programs.

Generally speaking, and referring back to table 1, countries that have only traditional and semi-traditional industries (status A or B)possess primitive ceramic industries, usually producing only pottery and faiance, with perhaps an incipient heavy clay products sub-industry. Some of the more advanced countries (C) will have borrowed the techniques for manufacturing stoneware, whiteware and perhaps porcelain, along with a competent heavy clay products industry, but it is almost always the case that a refractories industries is absent until some of the universal industries are set-up

Statistics were collected and it was observed that in highly developed countries the refractories and heavy clay products sub-industries vied for first place in importance within the ceramics field, followed quite some distance away by whiteware, stoneware and porcelain, with ordinary pottery and faiance last.

Nation-wise surveys were made by first sending simple questionnaires, so worded and structured as to give the manufacturers full opportunity

for supplying all the requested information. Along with the questionnaires , were sent circular-letters requesting samples of all raw materials in use , and the formulations used for any particular manufacture.

As the answers were being received, visits to the plants were made not so much for the establishment of direct personnal contacts, but mainly to size up and classify the plants at the same time their particular technological problems were evaluated and tabulated.

b) Documentation

At the Institute's General Library a file was opened, comprising all data already available on ceramics, while more works were being ordered and subscriptions taken to the most important ceramic journals.

The whole collection of the "Chemical Abstracts" was followed up, entries on ceramics studied, the references and abstracts extracted and filed.

Filing is conveniently arranged by subjects and according to the decimal system of classification. Full informations can be obtained on any subject, by looking up the pertinent cards, referring back to the copied abstracts of the works and ordering of the required material through the General Library.

For any other data, such as statistics, help is always sought at the Institute's Information Centre, which ought to have all the answers.

c) Laboratory facilities

Since most manufacturers of whiteware and porcelain possess fairly well equipped control laboratories at their plants, and since another Government entity - the National Laboratory of Civil Engineering - is equipped for testing heavy clay products, the initial facilities were directed towards control of raw materials and manufacturing processes, with emphasis on the fields of refractories and heavy clay products.

A selection was made of the methods and techniques for scientific and technological control of ceramic raw materials and manufacturing cycles and technical personnel was trained in the application of those techniques, which were standardized.

All facilities available at the Institute's other centres are always at the disposal of the Ceramics Unit for any work beyond the immediate capability of this unit, which could start off with the minimum of initial capital outlay and can grow in a precisely controlled manner, in exact accordance with the industry's needs and demands. Also, in the rare cases where special work be required, involving expensive or specialised equipment not yet available at the Institute, cooperation is assured from other Government Services, and even private concerns.

A small all purpose ceramic pilot-plant is planned to grow within the Unit, for industrial research on unit processes and a provisional list of the equipment that will make up the complete unit appears in table 2.

To facilitate as much as possible the handling of materials for analysis, special entry books are kept, every material receiving an identification number. A work schedule is set up by the laboratory supervisor, on the appropriate work distribution sheet, which is handed over to the analyst with the material and the reporting sheets that cover all tests, analyses and determination to be done.

In Table 3, there is shown part of a work distribution sheet (for clay-type raw materials) and in Table 4 is given an actual example of a report sheet (on workability index).

From each collection of report sheets on any given material is made out the final analysis report, copy of which is sent to the interested party.

c) Collection of samples and classification

In the few cases where samples were not returned with the questionnaires, they were collected during the visits to the plants. All samples were progressively analysed and tested, priority being granted to the heavy clay products raw materials, for the reasons already mentioned, viz. the relative importance of the different ceramic sub-industries and the existance of plant laboratories in most whiteware and porcelain factories.

In addition to full testing of each clay, particular attention was given to the study of the technological properties of the different clay mixtures used. As is known, it is seldom that one is lucky enough to find a natural clay deposit that yields a raw material exactly meeting one's needs.

In this way, to obtain products with the required properties, producers have to select and mix two or more clays. Without sufficient scientific backing and technological control it is almost impossible to reach the ideal compositions and empirical tests yield only approximate results. A simple case, in brief outline, will help illustrate the point. A brick and roofing tile plant had access to three different clays, that can be called A, B and C, respectively. By trial-and-error they had arrived at the following raw clay compositions; for bricks, 1/3 each of A, B and C; for tiles, 5 parts of A, to 3 parts of B, to 2 parts of C. The products were well within existing building standard specifications and no difficulties were experienced in marketing the ware. However, complaints were often heard from roofing tile buyers, especially about growth of fungi on the roofs. Physical and chemical analysis of the clays helped in classifying them, but it was the tests on fired molded specimens that fully revealed each clay's technological properties. Triaxial plots were made to obtain the property-lines, i.e., the direction of change with composition for any given characteristic, such as colour, resistance to abrasion, water absorption, density and so on. A simplified plot is given in Figure 1, with some of the property-lines indicated, that give a clear picture of the problem. It was found that the mixture in equal parts was, indeed, nearly ideal for brick-making, since the only shift in composition that would not lower the water absorption capacity (which is required for the laying of the bricks) nor the resistance and hardness (beside other factors not shown in the figure) had to move within the Y-area. However, any shift in the Y-area, even, would affect the colour of the finished product (not to mention other characteristics again) and so the composition used should not be changed. As regards the tiles, improvement was possible, for most properties could be bettered for compositions within the X-area, although the shift in composition had to be limited by other factors such as firing shrinkage and texture of finished ware. Tests on mixtures of the three clays confirmed the results and the information was made available to the manufacturer, who can now produce better tiles by using a mixture of 3 parts A to 1 part each of B and C, instead of the original composition.

This is only one among many cases where scientific and technological control helped better a product, but it shows how really simple the tests can be that will benefit an industry which has grown heedless to science and technology.

3. FINDINGS OF THE PRELIMINARY SURVEYS AND INVESTIGATIONS

a) Standard terminology

When planning the questionnaires it was feared that no standard terminology existed in the Country, and care had to be observed in setting

out the names of products that might be used by the industry. For example, one of the items was marked simply 'CLAYS", with blanc lines following for the types to be filled in by the users, no attempt being made to even exemplify with words such as "bauxitic","burley","diaspore", and so on. These fears were fully justified as the answers proved.

A similar disturbing lack of standard terminology was observed with respect to raw materials other than clays, as well as to materials in the various stages of manufacture, to manufacturing unit processes themselves and to even the plant equipment. Regarding finished products, however, the position was generally good all over the Country, and if manufacturers can reach agreement here, there is no reason why the same cannot be done on all ceramic terms.

b) Porcelain, Stoneware and whiteware:

This was found to be a rather flourishing group and with good reason, too, for if not scientific, at least technological control was being conscienciously applied.

These producers are aware of the necessity to keep up with all technical advances, by direct pressure from the buyers, who know just what they are looking for and who are not prepared to pay for inferior quality ware, when they know there is, or can be, better, national or imported. So, in order that good-quality reputation be established, and maintained, manufacturers have to keep the strictest control on raw-material input, along the processing and on product output.

In general, these plants possess small but fairly well equipped and staffed laboratories controlling raw materials as received and after preliminary treatments at the plant. It is unfortunate, but there still does not exist in the Country any reliable group of ceramic raw material suppliers who can guarantee and maintain quality of supplies, a vacuum that must be filled as soon as possible.

These laboratories usually control manufacturing cycles, which are set to rigid norms, and also perform routine tests on finished products. In limited scale, some applied research is also carried out, but in a rather unscientific and selfish way, with little or no cooperation amongst the different producers. Upon completion of the Institute's Ceramic Unit, all research can be concentrated with obvious benefits.

c) Ordinary Pottery and Faiance:-

The few large faiance plants that exist are facing a difficult period, sales declining in spite of increased exports, and, without sufficient technical resources to change this tide, a slow death is very definitely setting in. There still exist all over the Country a host of small works producing ordinary pottery and their future is still more doubtful.

These fields have remained impervious to all scientific advances Most plants are under-staffed and these manufacturers do not have in their vocabularies the word "mechanization". Controls are purely empirical and even kiln temperatures are seldom measured and recorded. Raw materials are never analysed, being simply tried out and when they prove well, the largest possible amount is bought and stocked to avoid for as long a time as possible new tests when re-stocking. Quality of the finished ware is also seldom controlled except for looks and obvious body failures and defects. Unless something be done by properly oriented basic research at the Ceramics Unit this group will soon have to cease production altogether as their products are unable to meet modern users demands and compete with aluminium, cement and plastic ware.

d) Bricks and Ceramic Tiles:-

Ceramic tiles and building bricks are usually made to standard shapes and sizes and some technological progress has entered the field, generally, although there is still little control on raw-materials and on the mechanical and physical properties of the products, with a few notable exceptions.

Like the porcelain, stoneware and whiteware field, this is a flourishing one, but a striking difference can be observed in the way growth is taking place in one and the other field. There is order and continuous quality improvement in the former, in direct contrast with the brick and tile industry. The main reason for the difference is not that bricks are easier to make than porcelain and so everybody wants to "have a crack" at making bricks and not porcelain. The main reason is that in the first-mentioned field the buyers are usually the end-users, who will just not take an inferior quality product, while in the heavy clay products the buyers are seldom the end users, being usually builders, who naturally enough care more about shape and price than quality. It is mainly because of this that internal competition is so great in this field, quality being sacrified for price. This is a case where rigid standard specifications and norms must be enforced at the same time an official standards and testing laboratory is set up taking charge of the spreading and teaching of modern control techniques for raw materials and manufacturing processes. That this route can and does lead to the desired goals is proved by the success attained by the self-imposed controls that are at work in the porcelain and whiteware industries.

Mention should be made here of the refractories industry, still in its infancy in the Country and which can be considered as a universal one (referring back to table 1), not needing much help, except in the study of locally available raw materials, since manufacturing and testing know-how can be obtained when plant and test equipment is bought.

4. CONCLUSIONS AND RECOMMENDATIONS

a) Standards and Testing Laboratories:-

As could be inferred from the related facts, a standards and testing Laboratory is a real necessity as far as the ceramics Industries are concerned, but it is not sufficient that standards and norms be set and enforced for finished products with the pertinent official testing facilities. It is necessary that in the same way and at the same time standards and norms be established for raw materials, and scientific and technological counsel made available to all manufacturers. A laboratory of this type must be equipped and staffed so as to be able to study all ceramic raw materials, intermediate and finished products, as well as unit processes. In addition, short and long-term research programs must be persued for the benefit of the industry, and facilities provided for technical training of manpower for the industry, with abstracting of selected ceramic literature to be made generally available.

b) Plant controls:-

Ceramic plants should have the following functions properly applied -control of quality, inspection and guarantee of quality, Quality control is the responsability of the supervisors, who must have the minimum of technical training. The plant laboratory must be in charge of inspection and collecting of samples and other information of technical nature through the supervisors as well as routine analysis and tests. The guarantee of quality must rest with the technical director and/or an official standards and testing laboratory. Other types of control, such as statistics, must obviously be applied as in any other industry, and need not be mentioned.

c) International Terminology, norms and standards:-

Although much is already being done to set up international glossaries and technical standards, data have not been made generally available and it would greatly help the ceramics industry if the results so far obtained were revealed. Tentative proposals should be put to the test immediately in order that final and proved glossaries, norms and standards for ceramics raw materials and products be internationally agreed on as soon as possible, and before new nations on the way to industrialization set up ceramic industries, develop their own standards and norms, and so complicate the issue.

APPENDIX

TABLE 1 - BROAD CLASSIFICATION OF INDUSTRIES

TYPE OF INDUSTRY	1. TRADITIONAL	2. SEMI-TRADITIONAL	3. FOREIGN (BORROWED)	4. UNIVERSAL
EXAMPLES IN PORTUGAL	Fishing (canning) Fruit (canning) Wines Cork products	Ceramics Timber, Resins Textiles Leather	Glass Sugar Oils Beer	Petroleum prods. Heavy chemicals Cements Metal smelting
GENERAL TENDENCES	To develop slowly but steadily	To become traditional	To develop and become established too rapidly, then fall into types 2,1	To become every country's need rarely falling into types 2,1
NEEDS AND CARES	Very often new blood is needed Seldom can help be sought abroad Basic research must be carried out Producers must be educated.	Same as for 1. Usually help can be obtained abroad and so cooperation is needed as well as basic research.	Country-wise initial selling-out of the idea is needed as well as technical and financial help. Growth must be controlled.	Considerable investments are necessary but plants and know-how can be purchased. Must keep up to world progress
COUNTRY'S INDUSTRIAL STATUS A	▨			
B	▩	▩		
C	▨	▨	▨	
D	▩	▩		▩
E	▨	▨	▨	
INTER-RELATION	← · →			

TABLE 2 - EQUIPMENT FOR THE COMPLETE CERAMICS UNIT

One petrographic, one binocular, one projection (for microphotography) and one heating (for sintering and melting points) microscope; X-ray diffraction apparatus; dilatometer; rotational-type viscosimeter; differential thermal analysis apparatus; plasticity, particle-size and base-exchange equipment; thermogravimetry balance; complete laboratory equipment for chemical analyses; pH Meter and recorder; standard sieves and shaker; laboratory types ovens and mufles; flame spectography equipment; turbidimeter; colorimeter and brightness meter; water-deioniser; small centrifuge; flask-shaker; mechanical stirrers; Bouyoucos hydrometers; pyrometric cone equivalent furnace; hydraulic presses and moulds; apparatus for deformation-under-load; panel spalling furnace (ASTM type); transverse strength apparatus; equipment for thermal conductivity (ASTM type); sound analyser, for ring test; abrasion test equipment; jaw crushers; disc type grinding machine; ball-mill; vibratory screens with magnetic separators; floatation cells; dry and wet pans; de-airing extruder; electric ovens and kilns; air elutriator; large centrifuge; jiggering machines; settling tanks; filter presses; pipe formers; glazing and painting equipment; pelletizer, for bloating clays; Mace sinter hearth apparatus (for light weight aggregates) and drilling machine, for clay deposits.

TABLE 3 - WORK DISTRIBUTION SHEET

0.1	CLAYEY MATERIALS	DETERMINATIONS AND TESTS FOR SAMPLE NO										DATE- ANALYST-	
Report no.	TESTS	REQUIRED DETERMINATIONS											Date finished
1.1	Chemical analysis	Ign. loss	SiO_2	Al_2O_3	R_2O_3	CaO	MgO	Na_2O	K_2O	TiO_2			
1.2	Particle-size (sieving)	Use sieves			Draw Graphs			Method					
		No.	to No.		A	B	C	Dry	Wet				
1.3	Particle-size (hydrometer)	TAKE READINGS FOR ___ DAYS ___ HOURS											
1.4	Particle-size (Pipette)	TAKE READINGS FOR ___ DAYS ___ HOURS											
1.5	pH-Deflocculation	pH as received ☐			Addition Na_2CO_3 ☐			Graph ☐					
etc.	etc.	etc.											

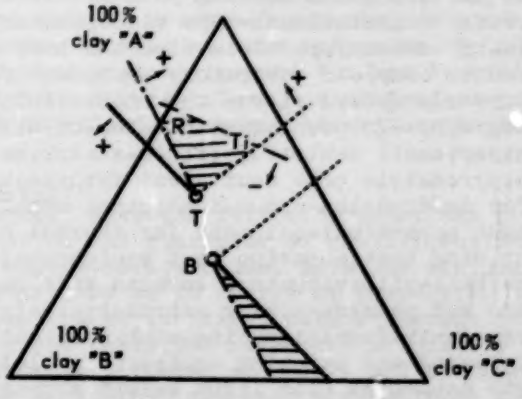
TABLE 4 - EXAMPLE OF TEST REPORTING SHEET

1.9	Workability Index	REPORT ___ SAMPLE NO.	Date- Analyst-

ASTM RAMMER. FOUR TESTS ON 300g. EACH. TEN IMPACTS, UPEND, TEN IMPACTS. TAKE LENGTH WITH SUSPENDED WEIGHT (A CM.) LOWER WEIGHT. THREE IMPACTS LENGTH (B)

SPECIMEN NO.	READINGS		DIFFERENCE (D=A-B)	WORKABILITY INDICES (100D÷ A)
	A (CMS)	B (CMS)		
1.				
2.				
3.				
4.				
If specimen crumbles report here			AVERAGE	

B = Brick composition
T = Original tile composition
Ti = Improved tile composition
R = Region of coarser texture



---------- Colour lines
—·—·—·— Resistance lines
———— Absorption lines
— — — — Shrinkage lines

Fig. I - Property-lines plot

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C O R R I G E N D U M

Agenda Item D.1.3 should read : D.3.3

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SUMMARY

Agenda Item: D.1.3

Portugal

CERAMIC MATERIALS AND PRODUCTS
TECHNIQUES OF SCIENTIFIC AND TECHNOLOGICAL CONTROL

By A. J. C. DE CARVALHO,
B. Sc., Chem. Eng., Rand, Ph. D., London

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AGENDA ITEM D.1.3. SUMMARY

CERAMIC MATERIALS AND PRODUCTS -

- TECHNIQUES OF SCIENTIFIC AND TECHNOLOGICAL CONTROL

by A.J.C. de CARVALHO
B.Sc. (Chem.Eng.) (RAND)
Ph. D. (LONDON)

1. Investigations for the improvement of the technological and industrial applications of a Country's natural resources.

In Portugal the National Institute for Industrial Research is carrying out investigations of this type, all aiming at the improvement of the Country's more traditional industries, such as ceramics, the object of this work.

2. Plan of action and facilities available in the field of ceramics.

(a) Enquiries and contacts with the industry-

By direct observation and surveys the status of the art and its evolution trends were clearly pictured as it appeared at home and abroad

(b) Documentation-

Full documentation was collected and a comprehensive library slowly built up, with special emphasis on modern techniques of analytical and technological control of raw materials and finished products.

(c) and (d) Laboratory facilities, collection of samples and classification-

Laboratory facilities are described as well as the techniques used in collecting and classifying industrial samples Nationwise.

3 .Findings of the preliminary surveys and investigations

(a) Standard terminology-

The necessity was observed for the setting up of a standard terminology, specially for the industry's raw materials.

(b) Porcelain, stoneware and whiteware-

It was found that generally speaking, these fields were thriving owing to reasonable technical control on materials, products and in all stages of manufacture proper.

(c) Ordinary Pottery and Faiance-

In these fields a slow death was observed, having remained almost impervious to scientific and technological progress survival seems difficult against competition from aluminium, plastic and cement products.

(d) Bricks and ceramic tiles -

Not dying, but hardly thriving, this field suffered fierce internal competition, the main reason for this being that the buyers are not often the end-users of the products and so place cost above quality and this is a case where production norms and standards should be legally enforced.

4. Conclusions and recommendations

(a) Standards and testing laboratories -

Full justification being found for the existance of a ceramics standards and testing laboratory recommendations are made as to its functions.

(b) Plant controls -

These are described and prescribed.

(c) International terminology, norms and standards -

It is urged that international agreement be reached as soon as possible on terminology, norms and standards for ceramic raw materials and products.

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Agenda Item:D.9.3

United Kingdom

THE TEACHING AND APPLICATION OF MANUFACTURING TECHNIQUES AND PROCEDURES

By F. KOENIGSBERGER
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THE TEACHING AND APPLICATION OF MANUFACTURING TECHNIQUES AND PROCEDURES

By

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The Manchester College of Science and Technology.

1. The technology of production is perhaps best defined as the technology of converting ideas into designs, and designs into realities, in a manner which ensures that the product is both technically efficient and economically competitive. Success depends finally on the efficient combination of theoretical and practical necessities and possibilities. The teaching and application of manufacturing techniques and procedures must, therefore, be theoretically sound without being divorced from considerations of practical aspects.

2. The knowledge and ingenuity of scientists and engineers together with the experience and skill of technicians and craftsmen have helped in developing the manufacturing techniques and procedures at present used in the industries of the world. Their successful application demands not only sound planning and provision of the necessary equipment, but also the ability to operate and maintain such equipment in a state of optimum efficiency. The men who are to be entrusted with carrying out these tasks must, therefore, be taught the fundamentals of the processes, procedures and skills of their application, and the principles and techniques of running and servicing the equipment.

3. The manufacturing processes which have to be considered in this connection must be viewed less from the points of view of their immediate economic efficiency than from those of the operating conditions and the soundness of the product. Moreover, if a teacher is expected to produce, in a relatively short time, results which are to give rise to efficient industrial development, it will be unwise for him to try and cover every possible aspect, process and procedure available anywhere in the world; restraint may, in this case, be preferable to excessive ambition. As it would further be imprudent to attempt the introduction of sophisticated techniques before the basic techniques are thoroughly mastered, priority should be given to the study and application of those processes and procedures which are particularly suited to the prevailing climatic and living conditions, which are essential, easily taught and quickly applicable, and which at the same time cover the most urgent specific industrial needs. Special consideration should also be given to the fact that skilled and experienced operators are unlikely to be

abundantly available during the initial period of industrial development. Moreover, the teaching of manufacturing techniques must not be directed exclusively towards the creation of new products. It must be equally concerned with the maintenance and repair of products imported from the industries of the world. A certain degree of industrial independence should, however, be the immediate aim, and a trend of development from the maintenance of imported products towards the manufacture of new ones should be borne in mind.

4. The following considerations must govern the planning of the teaching programme.

(a) The technical and economic efficiency of manufacturing techniques and procedures depend upon:-

(i) The selection and correct application of the process which is most suitable for a particular case;

(ii) The knowledge of the parameters which affect the efficiency of the operations, as well as the cost and the quality of the product;

(iii) The skill of the operator who is carrying out the work.

(b) The teaching and training must, therefore, be approached on three levels:-

(i) The education of qualified engineers who are to study the fundamentals and are able to carry out research into specific problems;

(ii) The teaching of technicians who are to plan and supervise the operations in the workshop;

(iii) The training of craftsmen.

5. At what might be called the academic level, the teaching should aim at bringing out those parameters which affect the production efficiency. The subjects to be covered include, therefore, the mechanism of the processes, the types and capacities of plant and equipment and the cost of installation, handling and maintenance. Engineering problems cannot be separated into watertight compartments and the foundation for success in applying different manufacturing methods is laid at the design stage of the products, and during the development of suitable techniques for their manufacture and quality control. The academic teaching must, therefore, include the fundamentals of engineering design, metallurgy and metrology and it must be backed by laboratory testing and research.

6. Although it is possible to send students from the less developed areas to established places of study in the industrially more developed countries, suitable teaching and research facilities must be provided at an early date within the countries in which such students are expected to carry out their work. The initial handicap of lacking tradition may be overcome, during a "running-in" period, by the appointment of experienced teachers who have at their disposal good laboratory facilities.

7. The laboratories need not be filled with a great variety of plant and equipment. It is more important that the essential points of some typical processes under discussion are brought out. If, for example, a reasonably well equipped workshop is available for manufacturing research equipment (see e.g. paragraph 11 and 12), the following may form the nucleus for a laboratory dealing with metal cutting on the "academic undergraduate and post-graduate level":

(a) A rigid centre lathe (at least 25 HP with an infinitely variable speed range of 20-2000 r.p.m.);

(b) Rigid milling machines, if possible one horizontal and one vertical machine, (at least 15 HP with a speed range of 15-1500 r.p.m.);

(c) A tool and cutter grinding machine for the above;

(d) A cylindrical grinding machine;

(e) A small radial drilling machine;

(f) Equipment for cutting force measurement (see paragraph 12);

(g) Vibration excitation and measuring equipment;

(h) Precision metrology equipment for dimensional, shape and alignment measurement.

8. Apart from those who are to introduce a process into industry, ensure its correct application, and keep its use and development in line with developments elsewhere, a large number of men and women must be taught how to plan and supervise the work whilst others must be trained in the operation of theequipment. Perhaps the easiest of these jobs is the training of the operators. This can be done by sending to various centres a certain number of trainees who after their return can help in training their fellow workers. A more difficult task on the other hand is that of teaching technicians who must not only learn the bare facts but must also understand the basic principles. Only a thorough explanation of the principles will lead to the full appreciation of the opportunities offered and the limitations encountered, thus enabling the students to see how best use is made of different processes, either singly or in combination. Moreover, the discussion of the techniques must be closely linked with an appreciation of the need for ensuring the required quality of the finished article.

9. Great care must be taken not to overload the practical man with theoretical knowledge nor to expect the technician to become an accomplished craftsman. For example, it would be futile to teach a craftsman welder the various features of automatic welding equipment, in the same way as it would be inefficient if a welding engineer were trained in the most effective handling of manual arc welding sets at the expense of not being introduced to the possibilities and limitations of automatic equipment. It is also a mistake to mix teaching workshops and laboratories. The future engineers and technicians have to study the various parameters for obtaining satisfactory results under varying conditions with different processes and equipment, applied to different materials and for a variety of purposes. Demonstrations combined with explanations of the principal phenomena must be given in a laboratory to the technicians in order to acquaint them with the processes,

the problems of equipment maintenance and the principles of supervising operatives and inspecting finished products. Some explanations of such phenomena may, of course, be given to technicians by means of practical exercises in the laboratory, and valuable use can also be made of visual aids, especially the many films which are now becoming available and which can often bring out the essential points more clearly than demonstrations. The future craftsman, on the other hand, who has to be trained in handling the types of equipment which he will be likely to use, must be enabled to practice extensively the actual operations in a suitable workshop.

10. One of the most important tools in technical education is a generous supply of inexpensive technical books. Students at education institutes of University standard can be assumed to possess a working knowledge of English or another major language, and will thus be able to peruse the existing literature. Technicians and craftsmen, on the other hand, cannot be expected to be such linguists and for them books in their own language, either original or translations, must be provided. The contents of these books must, of course, be adapted to the state of the economic development of the respective countries, and any translations from major languages must, therefore, be thoroughly revised.

11. One of the difficulties often encountered in laboratory work is the fact that skilled demonstrators are required to handle the equipment because the students lack the necessary skill. On the other hand, a student may greatly benefit from some more direct practical contact with various processes. An example of how this problem can be solved may be shown for the case of welding. Here students have to study the parameters involved in obtaining sound welded connections under varying conditions, with different procedures and applied to a number of materials. The information which has to be conveyed includes the most important technological aspects, questions affecting the metallurgical and mechanical properties of the material and joints and problems of producing designs which take into account the possibilities and the limitations created by the application of welding to production and repair work. The simple arc welding device (Fig. I) which can easily be built, will enable the student to study arc characteristics, observe the phenomenon of arc blow, etc., at the same time eliminating the influence of his lack of skill when holding the arc. A welding electrode (a) is held in a standard electrode holder (b) by means of a clamping spring (c) which substitutes the hand grip of the operator. The electrode holder is held in carrier (d) which can swivel round fulcrum pin (e). A flicker movement of ratchet lever (f) pushes electrode (a) downwards to touch plate (g) on slide (h). After the edge of (f) has passed that of tail (i) of carrier (d) during the continuation of the downward movement of (f), carrier (d) is rapidly taken back under the pressure of spring (c) and an arc is drawn between plate (g) and electrode (a). Slide (h) can be moved along under electrode (a) either by means of hand lever (k) or by a power drive at a predetermined speed. If plate (g) is fastened horizontally to slide (h) the arc length will increase in accordance with the melting-off rate of the electrode; if plate (g) is fastened in an inclined position (g_1) the arc length can be kept constant by adjusting the travelling speed in proportion to the melting-off rate of the electrode. In both cases the movement of slide (h) can be carried out steadily by the student who observes the arc through welding screen (l). The welder's skill of

maintaining a steady arc length is replaced by the slide arrangement and the student finds but little difficulty in carrying out the experiment during which, for example, current and voltage measurements can also be taken under various conditions. The relation between arc voltage (increasing with arc length) and arc current for various types of supply equipment can then be determined, the phenomenon of arc blow and its prevention can be demonstrated under different conditions, and the student can carry out the complete experiment without being an experienced welder.

12. In the study of machining operations it is again unnecessary to use expensive equipment. Relatively simple dynamometers 1), 2), have proved most valuable for demonstrating and measuring the main cutting force components. For example, cantilever dynamometers as shown in Fig. II 2), can be produced in the workshop of a technical college, and quickly calibrated and easily used for a variety of experiments in the laboratory. The parameters affecting the performance of cutting tools can be demonstrated and little skill is required on the part of the student in handling these instruments.

13. In paragraph 3 the need for carefully selecting appropriate manufacturing processes was already mentioned. Whilst it would go beyond the scope of this paper to submit a complete list of procedures and techniques which are considered suitable for the purpose and which can be relatively easily taught and introduced into industry, some considerations affecting such a selection may not be out of place. At the 1962 Machine Tool Colloquium at Aachen Professor Opitz 3) gave a comprehensive survey covering the present position and importance of manufacturing processes. These can be grouped as follows:-

(a) Processes which produce primary components from the raw material (casting, moulding and forming).

(b) Fabricating processes for the production of components from a number of separate detail parts.

(c) Machining processes.

14. In general industrial practice the reasons for deciding on the selection of one of these processes are:-

(a) Technological, determined by:-

(i) Type and size of the product;

(ii) Material properties;

(iii) Quality required;

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1) Robinson, F. and Gregory, R. W., A Cutting Torque Dynamometer and Related Experiments, Bulletin of Mechanical Engineering Education, No. 4, July, 1953.

2) Heginbotham, W. B., A Simple Two Component Cantilever Lathe Tool Dynamometer, Bulletin of Mechanical Engineering Education, No. 7, January, 1955.

3) Opitz, H., Stand und Bedeutung der Technologie der Fertigungsverfahren, 11th Werkzeugmaschinenkolloquium, Aachen, 1962. Industrie-Anzeiger, 7 Sept. 1962.

(b) Economic:-

(i) Required quantities;

(ii) Cost of material;

(iii) Cost of equipment;

(iv) Cost of operation.

15. Whilst the items under 14. are, in fact, generally applicable, in the case under discussion the feasibility of employing certain processes, types of equipment and operations is further affected by:-

(a) The available facilities, viz:

(i) Site;

(ii) Power supply;

(iii) Transport and handling.

(b) The possibility of providing the manpower for planning the operations, for running and operating the equipment and for carrying out the necessary quality control:-

(i) Qualified engineers;

(ii) Technicians;

(iii) Skilled craftsmen;

(iv) Unskilled labour.

16. Among the items mentioned in paragraph 15. those under (b) are perhaps the more important ones for the case under discussion. A shortage of skilled machine operators may make the use of automatic equipment advisable. This requires, however, good planners, skilled machine setters, and last but by no means least, a very good maintenance staff. In this connection it may make matters easier, if some maintenance staff from the manufacturer of imported automatic equipment can be employed rather than relying on the skill of newly trained machine operators. It should also be remembered, moreover, that the raw material must be very thoroughly prepared when automatic processes are employed. An automatic arc welding machine, for example, does not produce a sound joint unless the plate edges are more accurately prepared than would be necessary for manual welding.

17. The need for skill in operating machine tools can be reduced by the use of jigs and fixtures, and if there is a shortage of skilled tool makers the use of universal fixture systems 4) will assist in producing the jigs and tools which are essential for interchangeable manufacture. The manufacture of interchangeable components in turn helps to reduce the load on the skilled fitting staff. If such components can be produced in accordance with generally accepted standards, they can be used, if necessary in conjunction with imported components, thus easing difficulties which may be caused, for example, by the lack of certain equipment. Interchangeable manufacture is, however, only possible if the quality control is based on sound metrological

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4) Barash, M. M., Heginbotham, W. B., and Oxley, P. B. L., Jigs and Fixtures from Standard Sets of Parts. Engineering, Vol. 185, 27 June, 1958.

principles, i.e. if suitable gauges are available and can be checked against reliable standards. This requires first class metrology equipment and, if possible, a standards room.

18. It would go beyond the scope of this paper to mention the many new processes which have recently been developed with a view to increasing productivity in the fully industrialised countries and which could help in establishing efficient industries in less developed areas. Among such processes are:-

(a) Precision casting: Production of moulds for castings by means of the "Plycast" process 5).

(b) Welding 6)

(i) CO_2 welding;

(ii) Electro-slag welding of heavy sections.

(c) Preparation of forging dies

Spark erosion machining.

(d) Forming processes 7)

(i) Cold extrusion;

(ii) Explosive forming;

(iii) Dynapack-forming,

and many others.

19. The essential condition for successfully starting industrial organisations, for effectively providing the necessary plant and equipment, and for applying the various manufacturing methods and techniques which make efficient production possible, is the availability of staff capable of carrying out the design, planning, supervision, execution and inspection of the work required. It may be argued that it is possible to import plant and machinery, and to invite from abroad qualified engineers and skilled craftsmen to carry out the work. However, the whole life of a country, and not only one particular factory, is involved in the processes of production which affect building, power supply, transport, communication, etc. to such an extent that the mere transfer of the plant and staff for one factory would be almost bound to fail. The most important task is, therefore, the creation of facilities for teaching and training the population in such a manner as to enable everybody to do his share in driving the country's economy along the road from hard work to prosperity. Rather than trying merely to supply the the equipment or even the actual products, it is the duty of the more developed and industrialised countries to assist to the utmost the people in the less developed areas in reaching their goal; in other words, to help them to help themselves.

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5) Heimann, K. W., Neue Verfahren auf dem Gebiete der Giesstechnik, 11th Werkzeugmaschinenkolloquium, Aachen 1962, Industrie-Anzeiger, 7th Sept. 1962.

6) Numerous publications on these processes have appeared in the Welding Journal, The British Welding Journal, Schweissen und Schneiden, etc.

7) See footnote 3).

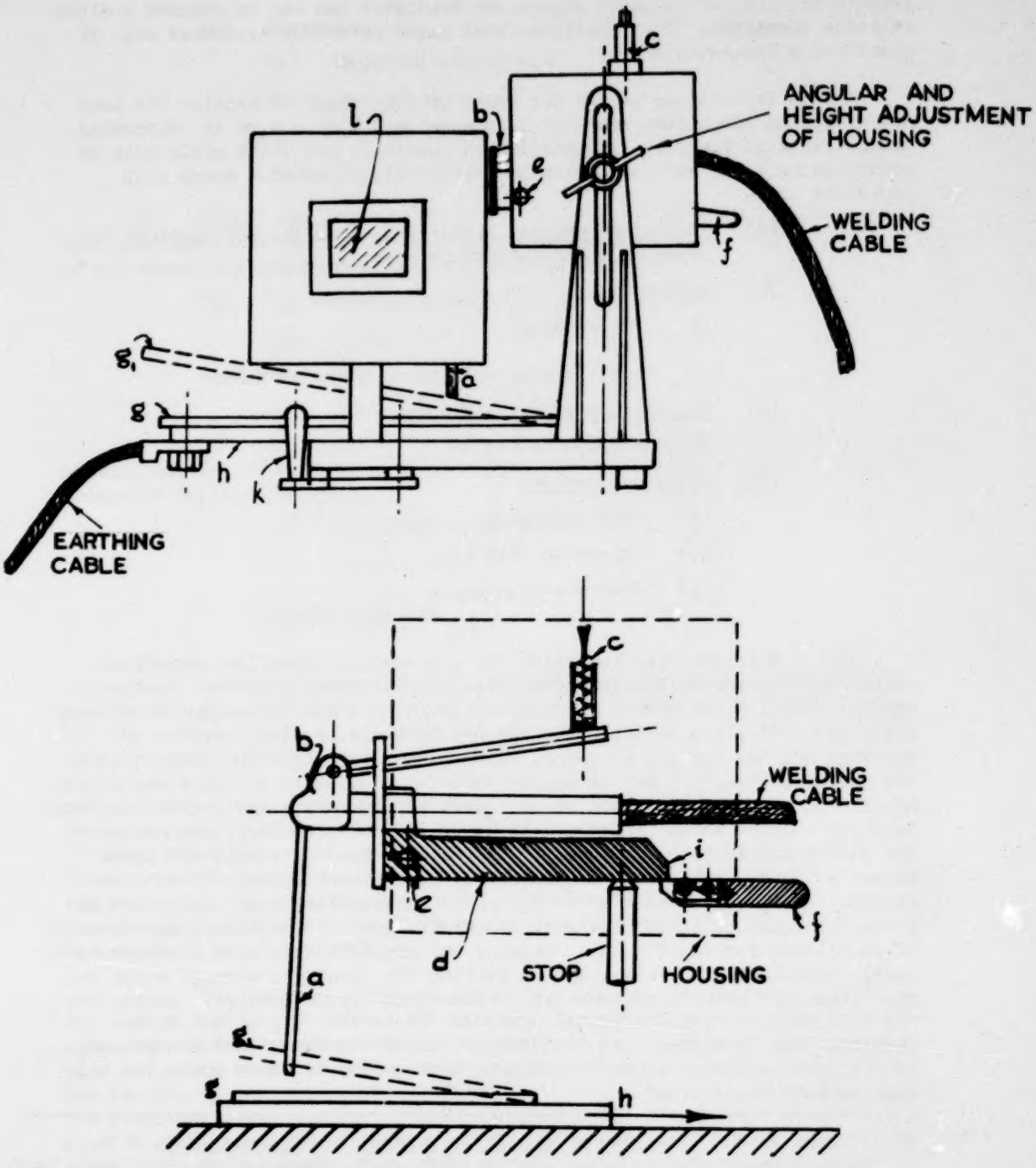
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Figure I.

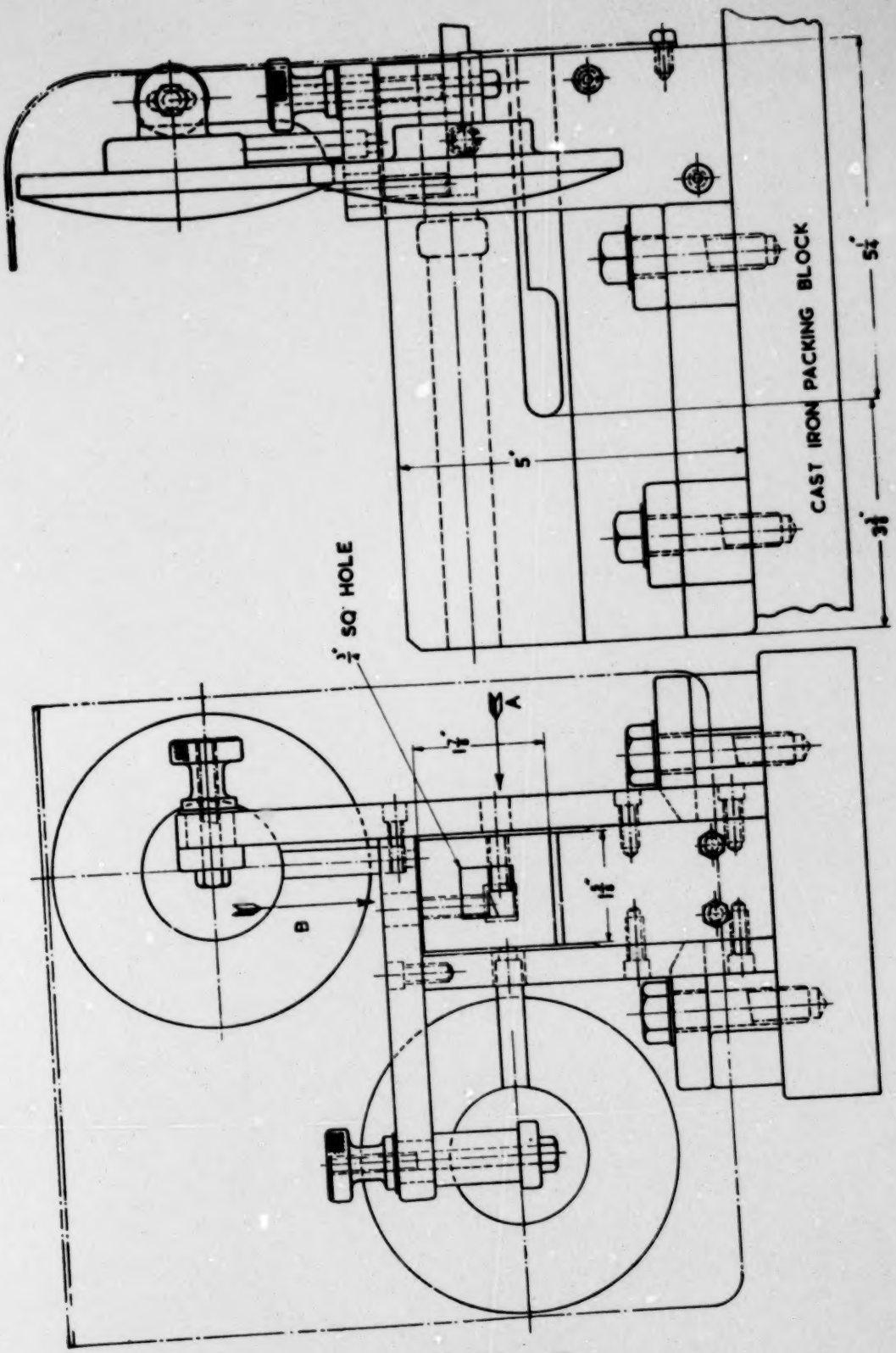

Figure II.

185 E - Sept.1962 - 1,600

E/CONF.39/D/6
SUMMARY
26 Sept.1962
ORIGINAL : ENGLISH

UNITED NATIONS CONFERENCE
ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D. 9. 3 United Kingdom

THE TEACHING AND APPLICATION OF MANUFACTURING TECHNIQUES AND PROCEDURES

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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THE TEACHING AND APPLICATION OF MANUFACTURING TECHNIQUES AND PROCEDURES

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SUMMARY

The teaching and application of manufacturing techniques and procedures must be theoretically sound without being divorced from considerations of practical aspects. The manufacturing processes which have to be considered in this connection must be viewed less from the points of view of their immediate economic efficiency than from those of the operating conditions and the soundness of the product. Priority should be given to the study and application of those processes and procedures which are particularly suited to the prevailing climatic and living conditions, which are essential, easily taught and quickly applicable, and which at the same time cover the most urgent specific industrial needs. Special consideration should also be given to the fact that skilled and experienced operators are unlikely to be abundantly available during the initial period of industrial development.

The teaching and training must be approached on three levels, namely, the education of qualified engineers, the teaching of technicians, and the training of craftsmen.

At the academic level, the teaching should aim at bringing out the parameters which affect the production efficiency, and should cover the mechanism of the processes, the types and capacities of plant and equipment and the cost of installation, handling and maintenance. Some discussion of the fundamentals of engineering design, metallurgy and metrology must also be included, and the teaching must be backed by laboratory testing and research. The laboratories need not be filled with a great variety of plant and equipment. It is more important that the essential points of some typical processes under discussion are brought out.

Apart from those who are to introduce a process into industry, ensure its correct application, and keep its use and development in line with developments elsewhere, a large number of men and women must be taught how to plan and supervise the work whilst others must be trained in the operation of

the equipment. Great care must be taken not to overload the practical man with theoretical knowledge nor to expect the technician to become an accomplished craftsman. Demonstrations combined with explanations of the principal phenomena must be given in a laboratory to the technicians in order to acquaint them with the processes, the problems of equipment maintenance and the principles of supervising operatives and inspecting finished products. Some explanations of such phenomena may, of course, be given to technicians by means of practical exercises in the laboratory, and valuable use can also be made of visual aids, especially the many films which are now becoming available and which can often bring out the essential points more clearly than demonstrations. The future craftsman, on the other hand, who has to be trained in handling the types of equipment which he will be likely to use, must be enabled to practise extensively the actual operations in a suitable workshop.

A generous supply of text books is very important. If such books are based on translations, these must be carefully revised in order to take into account the state of economic development in the country where they are to be used.

As far as the selection of processes and techniques is concerned, it must be remembered that a shortage of skilled machine operators may make the use of automatic equipment advisable. This requires, however, good planners, skilled machine setters, and last but by no means least, a very good maintenance staff. Moreover, the raw material must be very thoroughly prepared when automatic processes are employed. The need for skill in operating machine tools can be reduced by the use of jigs and fixtures, and if there is a shortage of skilled tool makers the use of universal fixture systems will assist in producing the jigs and tools wh ch are essential for interchangeable manufacture. The manufacture of interchangeable components in turn helps to reduce the load on the skilled fitting staff. If such components can be produced in accordance with generally accepted standards, they can be used, if necessary in conjunction with imported components, thus easing difficulties which may be caused, for example, by the lack of certain equipment. Interchangeable manufacture is, however, only possible if the quality control is based on sound metrological principles, i.e. if suitable gauges are available and can be checked against reliable standards. This requires first class metrology equipment and, if possible, a standards room.

The whole life of a country, and not only one particular factory, is involved in the processes of production. It is, therefore, necessary to create facilities for training the population of the less developed areas so as to enable everybody to do his share in raising the country's productivity, and it is the duty of the more developed and industrialised countries to assist to the utmost the people in the less developed areas in reaching their goal.

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Agenda Item : D. 9. 3

India

SELECTION AND NEW TECHNIQUES FOR ENGINEERING METHODS AND PROCESSINGS

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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D.9.3. Selection and new techniques for engineering methods and processings.

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1. From the point of view of economic development the Twentieth Century's greatest event is the widespread realisation among individuals and nations that were comparatively poor and backward that they are not permanently destined to be so but it is possible to improve their lot through conscious efforts by creating wealth from the human and material resources at their disposal. Application of technology plays the part of a catalyst in human efforts in the conversion of natural resources into wealth. Through the years a gamut of engineering processes and techniques have been developed from which choices could be made for applications to meet different situations on different scales of production. The choice of a process or technique found best in a set of circumstances may not be a right choice under another environment. The characteristicsof under-developed countries are a low per capita income, lack of technical knowledge, experience or skill, capital and a resistance from a large part of the population to any change in the socio-economic pattern of life. It is of paramount importance, an investigation or study be made before the choice of a process or technique is selected for use or adoption in an under-developed country. More harm could be done to an under-developed country by a wrong choice of technology for application in that country.

2.(a) Factors governing the selection of foundry processes relate not only to the types of metals and alloys melted but also to the shape of the products, the quantity involved as well as the subsequent operations which follow the casting process. The earliest melting processes must have used the charcoal fuel and later changed over to coal and coke. As regards the economy of melting and other considerations these processes had their own limitations such as temperature to which a furnace could be raised or the types of metals which could be melted, depending on the equipment that was available. Melting processes have been considerably modernised keeping in view melting economy and by means of increasing thermal efficiency of the process, apart from obtaining the required temperature. For instance, the old cupola practice for the production of grey iron castings has been modified

xxxxxxxx by using better quality coke, recuperative type of blast, keeping at the same time in mind the necessary alternations required in the designs of the furnace itself, to suit these developments. Similarly in the case of aluminium melting, better melting processes have been developed not only to avoid contamination of metal by the gas and other impurities but also to avoid overheating by means of automatic temperature controlled furnaces. Further in the case of alloy steels involving elements like tungsten etc., induction furnaces have found an un-rivalled position, because of the high temperatures they can attain and the Electro Magnetic Stirring which is so necessary for mixing the heavy and light metals to form the proper alloys.

(b) Considerations of industrial economics and speed have also given rise to modern processes like electric arc melting and the resistance melting. Industrial demands have given rise to vacuum melting applied to magnesium and its alloys. In all melting operations, apart from thermal efficiency, it is the availability of the thermal energy which is most important consideration. The direction of progress has been towards utilising the abundant resources of Solar energy for melting. The development on the castings and forming sides have been no less numerous from the days of primitive sand moulding to the modern days, Moulding was considered for a long time, more as an art than as a technique. Considerable mechanisation has crept into the field and has played its own part in the design of the castings. Bigger castings have been split up into smaller ones and more complicated ones into simpler ones. Hand-operated pin lift machines are still in existance today side by side with pneumatically operated jolt squeeze, roll-over machines which are fast yielding place to semi automatic and fully automatic moulding machines which are capable of bringing down the man-hours on the moulding operations. Similarly on larger castings human efforts have been replaced by sand slingers and pneumatic rammers, which not only ease the process but also give greater uniformity. Apart from sand moulding other casting methods like centrifugal castings, gravity die casting, pressure die casting and shell-moulding processes have been developed each with its own purpose. These processes are more influenced by the type of metal and product involved. For instance grey iron is more easily centrifugally cast while the non-ferrous metals are more easily die cast. As for pressure die casting special low melting alloys of medium strength are developed. A lot of development work has been done with a view to making the casting operations more precise and to minimise the subsequent machine operations. The modern shell moulding processes for small components like gears, are a fine example of this. It will also be interesting to note that roters for small electric motors are pressure die cast with aluminium replacing the general winding process. Considering the loss of metal due to shrinkage on solidification, continuous casting methods have been developed for straight shaped casting.

On the same line, core making pouring, fettling and cleaning operations have undergone extensive developments to suit mass production and to improve the finish. Complicated over baked cores have been replaced by quicker carboh-di-oxide process cores. Hand bruch cleaning of castings has given place to sand blasting and shot blasting operations in automatic and modern machines.

(c) Selection of engineering materials has undergone its own development. Old heavy iron castings are being replaced by lighter aluminium alloy castings as in the case of automobile cylindors and cylinder heads and in certain air craft parts. Metal components have been replaced by non-metallic components as in the case of certain gears and covers where plastics have taken in field.

(d) Developments in forging operations have similarly been influenced by the shape of the product, type of the material though however, many forgings are being replaced by castings due to purely economic considerations. From the simple hammer forge to the modern automatic hydraulic presses, the development has brought in more complicated products as well as much larger sizes. While the forging operations give rise to a dense metal structure it has its own limitation in the versatality of the products. While more complicated components yield themselves better to the casting process the sample components are more easily forged. Both the processes have their own advantages and disadvantages; for instance modular iron cast crank shafts are competing with forged alloy steel counterparts; complicated components like pistons are forged in preference to the castings for particular types. For long straight sections pressure extrusion has a good application especially in the case of non-ferrous metals and plastics.

(e) Side by side with the casting and other forgint techniques the need for better testing methods has also been fulfilled by laboratory developments in the chemical, physical and metallurgical fields. The old chemical analysis procedures have fast been replaced by modern and quick spectroscopic and electronic methods and old filing tests have been abandoned. Modern hardness and tensile testing machines have come into existence. Performance needs of the product have also introduced special testing-operations like surface finish testing, magnetic crack detection etc. etc.

(f) Safety demands in the aircraft industry have introduced the non destructive testing methods like X'ray Radio graphy. Other non destructive testing operations like supersonic tests have saved a lot of machine time by eliminating

defective components before they go into operation.

(g) Side by side with the development of casting and forgings, etc. there was also need for modern machines and machining techniques. With the availability of machines, a new thinking has come into existence with regard to mass production and engineering economics. Ford of United States are the best example. It is wellknown that they were the first to introduce the idea to divide the work in operations. The main purpose for this was to divide the machining operations into different categories keeping in mind different timings instead of doing various number of operations on one and the same machine. This necessitated the development of special machines for different machining operations. The quality of the materials to be machined also influenced the method of machining which has further necessitated the development of different types of machines, fixtures, cutting tools and coolants. Machining originally started with very simple materials like mild steel and cast iron with very oridinary tools, sometimes tempered steels, carbon steels etc. It was very difficult neither to attain the required accuracy, nor the finish. Development in the field of different special machines as well as the tools have made it possible now to answer the demands of accuracy in the modern industrial field. The use of tools like high speed tools, tungsten carbide, tipped tools, industrial diamonds and ceramics tipped tools have not only increased the production rate, the accuracy and the finish also have increased the tools life. Hand in hand, with this development greater care is being taken for the safety and health and comfort for the operators. From the simple lathes to the modern high speed automatics, there are a gamut of intermediate machines e.g. the semi-automatics and automatics. Where smaller quantities and the larger components are involved, simpler and individual operations are implied while smaller components with larger quantities adapt batch production methods. At the same time, larger components involving a number of operations, sometimes from the start to the finish, are machined on fully automatic machines. For example, machining of internal combustion engine blocks are machined on fully automatic machines and the bores are finished on multiple spindle automatic honing machines. Modern developments in machining process in Europe and other industrialised countries have not only helped to reduce the labour but also to increase the rate of production, uniformity and quality of the products. Simple machines have been converted into multiple operation machines by means of magnetic, hydraulic and copying attachments and manually operated machines have been converted into semi-automatic and full automatic machines using electronic systems, limiting the variety of the product and concentrating mass production of single type and individual type of production completely automatic machining lines were developed

in operation. These are mostly suitable for mass production using the minimum labour but the limitations will be that very highly technical skilled maintenance operators will be necessary to keep the installation running. It is needless to mention that such highly automatised installations are not always suitable not only for its poor employment potential but also for the lack of skilled technicians to maintain these. Compromising the production, quantity as well as the quality, semi-automatic machines have been found very suitable for less developed areas.

(h) The selection of finishing operations are governed by various factors e.g. protection from corrosion, exidisation, rustings etc., heat resistance, better running conditions as in the case of pistons in engines, better fitting and also for better appearance. For instance, automobile pistons are tin-coated, lead-coated, graphite coated or anodized as per the requirements of conditions while piston rings are chrome-plated, granodised, oxidised and tinplated. Combinations of one or more process are also in vogue. Whereas for finishing unmachined surface and components, painting is the usual practice, enamelling of metallic components has its own application. Brush painting has become obsolete in industrial finishing history. Modern spray painting on the most scientific lines has come into existence. As for electro-plating, simple operations have been replaced by batch operations and continuous plating process with the new techniques, methods and laboratory equipment, Mechanical polishing is being replaced by electrolytic polishing and buffing.

(i) In the early industrialisation, it was found necessary that the parts being cast or machined should be inspected so that the outcome is of a very high quality. For economy, this inspection has to be done during every stage of production or process of the intermediate product so that unnecessary operations on defective parts could be avoided. In addition to this normally a general inspection is being done at the end of the complete process to ensure that each part meets with the specification laid down by the manufacturers in accordance with the requirements of the consumer. Many methods have been developed on the machine itself to such an extent that the inspection equipments are controlled by the production machine too. In the early stages feeler gauges, whether good or bad, were being used. Later on indicators of different accuracies came into existence. After this, air operated and electrolytic devices with high accuracies and checking speed mainly for fully automatic machines were developed. In many cases, the inspection was developed to such an extent that highly complicated and fully automatic electronic devices had to be used. For instance, photo cells are used not only for checking purposes but also for the safety of the machine operators. Heavy machinery like presses are controlled by photo cells.

(j) In the very early days the parts made for assembly of a particular machine were not suitable for an assembly of another of the same kind. With the increase of production and production systems the need came that many parts of any one machine could well be used for in the assembly of another machine of the same kind - in other words parts of different machines of the same kind could be interchanged. This again made it necessary to develop the so-called fit system which laid down for different fittings exact measuring groups and tolerances. Parts produced in this manner opened the possibility for mass assembly in assembling line as is being done in the automobile, radio and telephone industries. Production of the line assembly system has made the assembly itself so simple that each person is doing a little bit of the job in a faster, better and cleaner way as also the tools and equipments implied in the system of assembly are modernised to suit each stage of assembly. Movements of materials and persons are reduced to a very great extent.

3. In choosing a particular technique or method for employment for production of an article involving the basi engineering process the facilities available is a governing factor . Even before a choice is made, it would be necessary to know the purpose for which the end product is required from the point of view of determining the order of limitations if any in its physical dimension and material specification. It is also necessary to know whether any alternative specification of the materials could be permissible, particularly in view of the substitute that may be made available locally. An other important factor/ is the volume of production for a particular product. A new process or technique, even when a choice is made from the considerations as indicated may have to be given up in place of another on account of higher costs involved. For different processes different raw materials may also be required. All these are further influenced by human skills that are available and ultimately the costs involved.

4. India, relatively speaking, could still be regarded as an under-developed country. It is a large country with a big population. Her needs for the products of the modern industry has been ever growing as in every other country. The country has fortunately considerable natural resources. Having this advantage she decided to industrialise herself and has been proceeding in that direction through the programmes as set out in her successive Five Year Plans. The first two Plans covered a period of 10 years from 1951 to 1960. She is in the third now.

(b) Basic engineering facilities that had been established in India before, largely served the sole purpose of servicing of several plants and equipment of imported origin operating in India , examples of these are the loco shops, automobile service and repair stations, auxiliary engineering shops in power houses, cement, paper and fertiliser factories. The first independent

basic engineering facility that came to be established was for for manufacture of several simple agricultural implements which were replacing some of those made of wood. These facilities, as the scale of operation increased, were gradully improved and modernised for quality control and achieving reduction in costs when competition arose. The first complete machine taken up for manufacture was manually operated pumps. This was followed with power driven pumps, sugar cane crushers including diesel engines. From these early beginnings a wide range of plant and machinery including machine tools have been undertaken for manufacture. The development has also been extended to cover electrical machinery and transport equipment, from bicycles to motor vehicles and locomotives and ships and even air crafts. Progress is also being made in the manufacture of house-hold goods such as sewing machines, radios, refrigerators, telephones etc. All these developments have demanded the need for more iron and steel, power transport and a multitude of other ancilliary products. Even during the processof these developments, the technological processes and techniques have undergone tremendous changes. In the whole field of industrial growth in India, she has taken advantage of the advanced industrial progress where-ever the results anticipated were in keeping with planned programme.

(c) With regard to MACHINE TOOLS, initially the manufacture of these was taken on individual piece basis and in cases the mating parts had to be matched against each other by manual methods to obtain the desired accuracy of the final product. With the development in the manufacturing techniques of machine tools the above process gave place to batch production using jigs and fixtures. This could only be justified by the corresponding rise in demand. A typical case would be the fitting of tail stock quills in the tail stock body on the basis of selective assembly. Later, as technique developed the two could be independently machined and fitted together in assembly with minimum hand work. Similarly scraping of mating parts was adopted when the demand for machine tools did not justify the use of special purpose grinding machines. The latter technique has now replaced scraping. In the manufacture of small tools there has not been any substantial difference in the manufacturing techniques adopted in India to those employed by foreign manufacturers for most of the items. Where foreign countries have developed new processes-the Indian manufacturers are trying to adopt the modern processes. A typical example is that of manufacture of twist drills where there has been a prgressive change in the method of manufacture keeping in line with the Western methods. For instance the flutes of twist drills used to be milled in the initial stages followed by operations like hardening, grinding etc. This method was replaced by a grinding method wherein flutes are straightaway ground on to hardened blanks. Even this process is being superseded by what is called the 'Flute Forging Method'.

(d) The bicycle and sewing machine industries in India have been established for large and small scale production. Modern techniques with installation of latest type machinesas are in vogue in the advanced countries are being used with advantage in the large scale factories. On the other hand the small scale units have adopted conventional methods of manufacture with machinery made in the country or duplicated. The malleable castings were used for hubs and B.B. shells but the use of such castings is now being discarded as a result of the introduction of pressed steel B.B. shell and pressed steel or tubular hubs castings. The widely used process in India is grey iron sand casting for all cast iron parts. Mechanised foundries based on modern principle of production flow with mechanical handling devices are there in India. There are smaller foundries having conventional manually controlled machines for several operations such as mould-making, cone making, iron making and cleaning and finishing. Die casting process in India is being widely used for variety of articles but its use for sewing machine industry is restricted. The question of amortisation of the cost of die casting equipments and dies vis-a-vis the offtake of the die cast parts restricts the use of this process in smaller factories. Recently there have been efforts to introduce powder metallurgical process and investment process in India for small intricate parts like shuttle, bobbin case etc. Aluminium arm and bed in sewing machine are replacing cast iron parts in Europe and America because of the advantage of the former in respect of lightness, better finish and saving of some machining operation. Due to shortage of aluminium all these years and dependence on imports for the equipments this process was not attempted hither to.

(e) In the field of Automobiles, the process and technique in the industrially advanced countries may be said to have reduced the human labour involved. For adoption of such techniques and processes the investment involved in establishing the services is so large, a developing country such as India could illafford and also because the scale of operation does not warrant such a techniques. The Indian Automobile Industry has a larger proportion of general purpose machines than could be found in places where mass production techniques are employed. This picture is continuously changing.

5. One of the crucial problems facing under-developed countries on the threshold of industrialisation is technical-know and this is particularly true of engineering industries, the establishment and operation of which makes large demands on a variety of specialisations and skills. Right from the stage of blue-printing of industrial projects to the selection of sites, development of land, buildings and ancilliary services, choice of raw materials, machinery range and diversity of output and

techniques, training and placement of production operatives and supervision of such personnel, a complex range of technical problems would pose the entrepreneur from day to day. The answer to this challanging task is of course for the country concerned to plan from the very beginning as a part of its national policy for a widespread establishment of facilities for spread of technical education both at the acamemic and practical levels. As this, however, is a time consuming process and as developments in engineering technology particularly in the more advanced countries are proceeding fast, it may be wise for any under-developed country, atleast in the initial stages to borrow technical know-how from the developed countries in any desired field, if it wishes to make rapid progress. The most practical and fruitful form in which such technical know-how can be made available by the developed to the under-developed countries is the conclusion of mutually beneficial private technical collaboration arrangements between well established firms in the former and entrepreneurs in the latter. However, the role of Government to Government technical assistance programme in furthering this objective has also a contribution to make Two outstanding examples of international technical collaboration at the present time in the field are the United Nations Expanded Programme of technical assistance and the technical co-operation scheme of the Colombo Plan. Besides there are bilateral Government to Government technical aid schemes sponsored by the industrially advanced countries like the U.S.A., U.S.S.R., France and West Germany. The types of industrial projects most likely to receive favourable consideration from these foreign technical assistance authorities are those which are designed to further industrial development in under developed countries as catalysts, applied selectively at crucial sectors of the national economy. The Technical assistance is available under these programmes in the shape of both foreign experts and fellowships abroad. This country has benefited substantially by drawing on such international programmes of technical assistance. In the engineering industries, during the last decade, there have been several visits by foreign experts in the field of industrial engineering , tool engineering, foundry and forging technology and metal finishing mostly from U.S.A. and Japan. There were visits by a number of experts in pinpointed fields of specialisation like furnace electrodes, coated and bonded abrasives, machine tools and calibrated steel chains. These experts have through specified periods of in-plant assignment to various industrial units helped to identify and solve on the shop floor a number of technical problems in raising production, improving quality, and lowering costs. Similarly several young engineers from several industrial units in engineering industries were sent abroad during the period under these programmes for acquiring advanced technical know- how.

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ON THE APPLICATION OF SCIENCE AND TECHNOLOGY
FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D.9.3

India

SELECTION AND NEW TECHNIQUES FOR ENGINEERING METHODS AND PROCESSINGS

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Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

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D.9.3. SUMMARY OF THE PAPER ENTITLED ' SELECTION AND NEW TECHNIQUES FOR ENGINEERING METHODS AND PROCESSINGS'

By

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Development Wing
NEW DELHI

1.(a) In this world of complex economy, the under-developed nations, after realising that they cannot exist without industrial advancement, are marching towards their avowed target with determination and zeal. In this march of progress utilisation of the tool of advanced technology is a must.

1.(b) Nevertheless, the techniques adopted in an underdeveloped country must be based on wise assessment of human reaction, existing condition of income, capital available for investment and the availability of technical skill. Hasty prescriptions may yield negative results. All the same a brief resume of the advance made in recent times by countries which are already industrialised in the basic techniques of engineering, which can be applied with good results in less-developed countries is essential.

2.(a) The foundry process for melting metals and alloys are governed by economy and increase in thermal efficiency of the process apart from obtaining the required temperature. There have been successful attempts also at utilising solar energy for this purpose.

2.(b) Minimising of subsequent machining operation is now the aim of precision casting. The selection of engineering material has also undergone revolutionary changes. Aluminium castings are now occupying the high pedestal which once was occupied by the heavy iron castings. Metal components are giving way to nonmetallic components. Owing to economic considerations the tough forgings are yielding place to versatile castings.

2.(c) Another important field in which considerable development has taken place is material testing - the aircraft industry contributing a great deal towards its advancement.

2.(d) The machining techniques have undergone tremendous change. Special machines and tools have not only helped mass production

xxxxxxx but also cut down the labour to the minimum, without any detrimental effect on either the uniformity or quality of the product. Automatic (mostly electronic) machines have replaced manual inspection in a record number of industries. The latest trend towards standardisation of hundreds of components that go into an assembly has contributed towards easy flow of materials besides cutting down considerably wastage. However highly automised installations are not always suitable for an underdeveloped country where employment problem will be a force to rechon with. Moreover skilled technician to man such machines are seldom readily available. Semi-automats have been found more suitable for such countries.

3. The situation that existed in India before she ventured on a planned development, was more or less similar to any that prevails in the underdeveloped countries, excepting for the fact that she had plenty of natural resources waiting to be harnessed. The basic engineering facilities that had been established in India, before 1950 served the sole purpose of servicing of several plants and equipments of imported origin operating in India. From these early beginnings a wide range of plant and machinery including machine tools have since been undertaken for manufacture. Whereever the results anticipated were in keeping with its planned programme, India has taken advantage of such industrial progress. In the manufacture of small tools the techniques adopted in India are almost akin to those in more advanced countries.

4.(a) All underdeveloped countries on the threshold of industrialisation are facing a common problem - lack of proper personnel to man the huge projects the establishment and operation of which demands a variety of specialisation and technical skill. The answer to this challenging task is of course for the country concerned to plan from the very beginning as a part of its national policy for a widespread establishment of facilities for spread of technical education both at the academic and practical levels. As a shortcut, it is advisible for underdeveloped countries to borrow, at least in the initial stages technical know-how from industrially advanced countries This can be done on either government to government basis or by conclusion of mutually beneficial private technical collaboration arrangements between well established firm in the industrially advanced countries and entrepreneurs in underdeveloped nation. The sooner such dependency by an underdeveloped country for the technical know-how is enabled to seize any aid that would have gone in during this transition period could be considered to have achieved its faith and object.

4.(b) Two outstanding examples of international technical cooperation at the present time in the field are the U.N. expanded programme of technical assistance and the T.C.M. Besides countries which are affluent like U.S.A., U.S.S.R., France and Germany have also been sponsoring technical aid to the underdeveloped nations. The types of industrial projects most likely to receive favourable consideration from these foreign technical assistance authorities are those which are designed to further industrial development in under-developed countries as catalysts, applied selectively at crucial sectors of the national economy.

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Agenda Item: D.2

Ghana

IMPACT OF LEGISLATION, TAXATION, SUBSIDIES AND TARIFFS ON THE VOLTA RIVER PROJECT NEGOTIATIONS

By E.A.K. AKUOKO

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SERIAL NO.40: SUB-ITEM D.8.2

IMPACT OF LEGISLATION, TAXATION, SUBSIDIES AND TARIFFS ON THE VOLTA RIVER PROJECT NEGOTIATIONS

BY E.A.K. AKUOKO

The Volta River Project consists of two separate parts: a dam and hydroelectric power station together with a transmission line covering the southern part of Ghana, which will be referred to in this paper as the power project, and an aluminium smelter that will use approximately one-third of the total output of power from the station. The power project is being constructed and on completion will be operated by the Volta River Authority, a public corporation set up under the Volta River Development Act. The Smelter will be constructed and operated by the Volta Aluminium Company Limited (called Valco for short) a private company formed in Ghana by the Kaiser Aluminium and Chemical Corporation and Reynolds Metals Company, both of the United States. The company will convert alumina belonging to the shareholders only. The smelter and the power projects are interdependent in as much the power project will offer a cheap source of electricity for the smelter, and the smelter will provide a guaranteed customer for the purchase of that proportion of the power which together with the consumption of present users will defray the capital cost of the power project.

Half of the funds for building the power project is being provided by the Government of Ghana and the other half in the form of loans by the International Bank for Reconstruction and Development, two agencies of the United States Government: the Agency for International Development and the Export Import Bank of Washington, and by the Board of Trade of the United Kingdom Government. All these loans are guaranteed by the Government of Ghana. The funds for the smelter are being provided partly by the shareholders of the company

and partly by a loan made available to that company by the Export-Import Bank of Washington.

The basic document underlying the project is the Master Agreement between the Government of Ghana and the Volta Aluminium Company together with its schedules. The Agreement was submitted to the Parliament of Ghana both after it was initialled in February 1961 and just before it was executed in final form in January 1962. The Agreement is intended to bind the country and not merely the Government; and after a White Paper had been published to explain its provisions, Parliament was called upon to pass a resolution in support of its terms and those of its schedules, thereby expressing their acceptance by the whole country. The Government undertakes not to amend or modify or prevent the due and effective performance of the Agreement and its schedules by any legislative or administrative act present or future. The Agreement looks ahead in stating that in the event of Ghana entering a confederation of African states or a customs union, its force and effect will not be impaired.

The Master Agreement sets out the respective rights and obligations of the Government and the company towards each other in prosecuting the project for a period ending thirty years following the commencement of the smelter operations. It contains a provision for making or executing all instruments and taking all such steps as may be necessary including exemptions from or repeal of all present and future enactments and administrative acts for the further assurance of these rights and obligations. This and similar provisions in the loan and other agreements relating to the scheme called for no less than twenty seperate legislative and administrative acts alone by the Government of Ghana.

First of all the Volta River Development Act was required to be enacted by the Parliament of Ghana before the execution of the Master Agreement. This Act provides for the setting up of a corporation independent of the Government except in matters of basic national policy, which was to be charged with responsibility for the construction and operation of the power project. Full executive powers are vested in the Chief Executive of the Authority subject only to the

general control of the board in matters of policy. The Authority's powers include those of local government over the township built at the site of the dam and power station and the area surrounding the lake that will be formed as a result of the building of the dam.

In addition to borrowing powers generally conferred on th Authority, Ghana is obliged under the Act to provide for it in the form of investments for the first ten years of the project sums required by the Authoirty up to a maximum of thirty-years million pounds. Such investments are charged on the Consolidated Fund of Ghana, which means that they do not require further specific appropriations by Parliament. Both the Master Agreement and the Authority's loan agreements disallow the repeal or amendment of the Act.

From the legislative and administrative point of view the most important provisions of the Master Agreement are those relating to the special tax regime created for Valco for the durations of the Agreement. The taxes to be levied against the company for the period of the regime and the manner in which they are to be levied are specified in great particularity. They include income tax, customs duties, stamp duties and road taxes. As regards customs duties, however, material and equipment needed for the construction of the smelter and in any mines to be operated by Valco are to be imported free of duty and restrictions. Similarly the importation of alumina for the smelter and the exportation of aluminium ingot manufactured at the smelter. The company is specifically exempted from payment of minerals duties in connection with the mining or processing of bauxite. It is also permitted, contrary to present statutory limits, to acquire bauxite concessions to an aggregate total of forty square miles.

In the case of income tax, the rate is fixed for the duration of the Agreement at the rate prevailing at a date one year prior to the signing of the Agreement, and in order to prevent any increase in this rate by altering the basis and manner of assessment the whole income tax ligislation as in force at that date is

annexed as a schedule to the agreement. The company is also brought within the reliefs available to a pioneer company under the general pioneer industries legislation. A complicated surgical operation was carried out here to accomodate the special terms of the Master Agreement in this regard, and also the special features of the tax regime which were put in this legislation for want of a better place.

Under the previous pioneer industries legislation, companies starting industries declared to be pioneer industries by the Government were granted relief from income tax on an amount specified in a special certificate issued to the company. This relief was available to companies resident in Ghana only, and since under Ghana law Valco would not be so resident, the first change made was to make incorporation in Ghana the test for eligibility for pioneer relief.

Formerly companies were accorded relief on the whole of their income for five years or such lesser relief as the Minister might specify. Earlier on in the negotiations Valco asked for a more definite relief, and an amendment was made to enable a pioneer company to obtain relief equal to its paid up capital at a named date which in Valco's case would be the date the smelter would start operating. This request was based on the assumption that the whole of the shareholders' investment in the company would be in the form of capital subscriptions; but later on when for fiscal reason it was arranged that a proportion only should be subscriptions to capital and the rest should be in the form of prepayments of the charges payable for converting their alumina the legislative formula for granting the relief was altered to take into account these prepayments. The final formula arrived at ain a second amending Act was for relief of such amount as the Minister may specify. This sounds like a legal merry-go-round, but the final formula is different from the first in one vital respect: a minimum holiday period of 5 years is now established in place of the period formerly available, which could be less than five years.

The tax holiday period previously commenced with the later of the start of the company's business and its "production" date as

stated in the application for relief. In the case of Valco however it was agreed that the period would not start until all the potlines of the smelter have been fully commissioned which will be eighteen months from the start of operations. It became necessary therefore to amend the law to enable the Minister to determine a third date for the start of the holiday period.

In assessing liability to income tax under the general law, the losses of a business are carried forward and offset against income at the first opportunity in subsequent years. Such losses are usually larger in the initial years of a business, and substantially reduced the relief granted during the tax holiday period. Valco required the maximum benefit from the holiday period which will be possible only if its losses during the eighteen months pre-holiday operations are not carried forward into the holiday period. Accordingly the law was further altered to enable any such losses to be frozen at the commencement of the holiday period and carried over to be offset against its post-holiday earnings. Before too, a company did not earn any capital allowances during its holiday period. During that period, however, its assets were depreciated at a rather high rate on a reducing balance basis, so that capital allowances earned on the depreciated assets in the post-holiday period were small. Valco asked for two changes here. First the company requested a reduction in the rate of depreciation during the tax holiday period, secondly they asked for this depreciation to be on a straight-line basis. The net effect of these changes is that at the end of the holiday period the value of the company's assets will be substantially greater than would be under the old law, and the capital allowances applicable to it will be correspondingly higher.

The amount of relief is expressed in terms of a foreign currency, i.e. dollars. The reason is that under their agreements for investing in Valco, the shareholders agreed to make payments in dollars, and naturally they want to earn relief on the actual value of their investment which would not be the case if the relief was on the Ghana currency equivalent of the investment and a change

occurred in the value of that currency before the full relief had been earned. It was therefore necessary to amend the law to empower the Minister to grant the relief in this manner.

None of the modifications made in the pioneer relief legislation will be automatically applicable to other companies. It would have been though impossible to make these numerous modifications without providing some windfalls for companies not contemplated by the agreements, but in all cases great care was taken to provide only such additional alternatives as were required to accomplish the special concessions granted to Valco, and to make the application of these alternatives discretionary so that the Minister can decline to apply them to other companies.

Under a provision in the first amendment of the pioneer relief law, the rate of income tax applicable to Valco during the stabilised tax regime was to be the rate generally applicable to companies at the date of issue of its pioneer certificate. It was anticipated at the time of that amendment that the rate of tax would remain the same when the certificate would be eventually issued as it was at the date at which the rate had been fixed for Valco. Before the certificate could be issed, however, certain changes had occurred in the general income tax law of Ghana which made it doubtful whether the rate of tax for companies remained the same after as before these changes, and in order to avoid any such doubt a further amendment was made to enable the Minister to apply the rate prevailing at any date in his discretion, the understanding being that the rate fixed would be that previously agreed.

The Master Agreement contain elaborate provisions dealing with exchange control, all of which have been embodied in a special set of Regulation under the relevant legislation and in letter issued to Valco by the Exchange Control Authority. To begin with the Government agrees to allow Valco to hold in an account outside Ghana receipts of foreign currency for the purpose of making certain specified payments including expenses in connection with the construction of the smelter any payments to its lenders and other vital creditor. Subject to this,

all Valco's receipts come fully under Ghana's exchange control jurisdiction, thought an assurance is given for the grant of exchange permits for other justificable purposes. Such consents are to be subject however to the general availability of foreign exchange in Ghana, and also to the retention of sufficient funds to meet the company's obligations in Ghana, particularly charges made by the Volta River Authority for the supply of power to the smelter. Applications for such consents are to be dealt on the most favourable standard. There is also an undertaking in general terms to grant exchange control consents to enable Valco to perform its obligations under the several agreements pertaining to the financing and operation of the smelter.

Under the contracts for the conversion of the shareholders' alumina, Valco may in certain circumstances extend credits to these shareholders for the tolling charge. For the purposes of exchange control, the Government agrees that such credits shall be used to offset the company's liabilities to the shareholders provided that sufficient funds are available for payments to other creditors of the company.

For the purposes of its operations in Ghana Valco requested an immigration quota under the immigration law for a number of overseas personnel, and this was established in a letter delivered by the Ministry of the Interior.

The Agreement contains other important assurances to Valco by the Government. First the Government assures Valco, its shareholders, its creditors and its employees against discriminatory laws and practices. There is a most important assurance against derogation from both those contracts scheduled to the Master Agreement by which among other things the Government grants Valco rights to land and in the port of Tema as well as for the supply of water for the smelter, and also those other agreements relating to the management and operation of the company. Any act of derogation is considered expropriation against which, as against conventional expropriation, elaborate sanctions are provided.

With regard to expropriation the Government undertakes for the period of thirty years not to expropriate or nationalize under any circumstances any right of Valco, or any share or security in the company held by any person. After that period any act of nationalization is to be accompanied by the prompt payment of fair and reasonable compensation in the original currency of the outlay. The terms used for this purpose include "intervention" which is defined as the assumption of power of management over any property of or interest in Valco which prevents the directors or officers of the company from exercising effective control over that property, or in the case of an interest in Valco, over the company; and also includes as regards shares or any security in the company, similar acts which prevent a share or debenture holder from exercising effective control over it. The only exceptions are acts in virtue of a court judgement or of a creditor. In the event of any act of nationalization, expropriation or intervention affecting a substantial portion of the rights of or in Valco, any of the shareholders can require the immediate nationalization of all the shares of Valco. Also if any such act materially affects the ability of Valco to meet any liability under any loan agreement in force between itself and any lender, all of Valco's liabilities under that agreement are automatically transferred to the Government. The rights vested in Valco by these provisions are extended to an are exercisable by Valco's shareholders. There is however, a provision for the company to give notice to the Government of any act which it considers to be expropriation, nationalization or intervention, and the Government is given two months within which to put the matter right. This clearly is designed to prevent inadvertent breaches of these important provisions which could entail quite serious consequences. Other more usual provisions relating to expropriation and nationalization are also included.

The provision relating to notification by Valco of acts of expropriation underlines the anxiety of all partners in the project not to see it founder on a mere technicality or inadvertence. This anxiety is further expressed in another legislation passed by the Parliament of Ghana stating that outside the Constitution, no existing

provision of the laws of Ghana shall make any of the agreements void or illegal. Taken together with the obligation of the Government in the Master Agreement to secure exemption from, or the repeal of any, any enactment that would interfere with or prevent the carrying into effect of these agreements, this provision renders the agreements governing the project virtually inviolable as far as the law of Ghana is concerned. The first occasion for testing the Government's undertaking to secure exemptions occured barely two months after the agreements were signed when a bill transferring all ports in Ghana from the Government to a new Ports Authority came before Parliament. The area in the Port of Tema which had been leased to Valco was exempted from the bill at the Government's request in order to retain the responsibilities it had assumed as lessor.

In addition to guaranteeing the Authority's loans, the Government agreed to guarantee the loans made to Valco in the event of nationalization or other acts of the Government which would avoid or prevent the due performance by Valco of the Master Agreement the funds arranged for the smelter if the cost exceeded those funds, which include a generous provision for contingencies. Under the Ghana Constitution it was not entirely clear whether the Government had power to provide such guarantees and a special power had been inserted in the Volta River Development Act to enable the Government to offer the guarantee on behalf of the Authority. A similar power became necessary in respect of the guarantee of Valco's loan. These powers together with the provision immunizing the agreements from the law of Ghana were put in an omnibus Act which was passed just before the signing of the Master Agreement. The same Act contains a clause which excludes the agreements, which are governed by the law of Ghana, from the operation of the new Contracts Act of Ghana. This latter Act contains provision under which third parties could benefit from certain provisions of the agreements which were intended to be exclusive to the parties.

All the loans made for the project required exemption from Ghana income tax which normally would not call for special legislative action since all the lending institutions are governmental bodies. But as the loan agreements provided for the transfer of bonds issued

in support of them to private persons, a change in the law was required to exempt the bonds from tax so long as they are in the hands of private persons not resident in Ghana. Three of the lenders to the Authority also required payment by the Authority of all stamp duties in connection with the loans, and it was considered desirable to exempt the Authority from payment of this duty altogether.

As a result of the stabilised tax regime accorded to Valco and also of the provisions of the loan agreements, a number of exemptive orders became immediately necessary. These included a resolution by Parliament under the Customs Law, and Orders under the Minerals Duty Ordinance, the Purchase Tax Act, the Property Tax Act and the Compulsory Saving Act, as well as under the Income Tax Ordinance.

In a sense these orders provide indirect subsidies by which the smelter enterprise has been attracted to Ghana. But there are other more direct subsidies. The rate charged for the supply of water for the smelter is substanially less than that charged for supplies to other customers. The port lease was also granted on very favourable terms. In the same way the rent fixed for the lease of the smelter site is about one-fifth of that usually charged for comparable land. In addition the Government has accepted a ceiling on the rates chargeable on these properties by the authorities and agreed to pay any excess levy above this ceiling.

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FOR THE BENEFIT OF THE LESS DEVELOPED AREAS

SUMMARY

Agenda Item: D. 2

Ghana

IMPACT OF LEGISLATION, TAXATION, SUBSIDIES AND TARIFFS ON THE VOLTA RIVER PROJECT NEGOTIATIONS

By E. A. K. AKUOKO

Papers have been contributed to the United Nations Conference on the Application of Science and Technology for the Benefit of the Less Developed Areas as working papers for that Conference. They are published as presented by the contributors, and the contents and the views expressed are those of the contributors. (See notes overleaf.)

NOTES

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IMPACT OF LEGISLATION, TAXATION, SUBSIDIES AND TARIFFS ON THE VOLTA RIVER PROJECT NEGOTIATIONS.

BY E.A.K. AKUOKO

The Volta River Project consists of two separate but complementary schemes; a scheme for building a dam to produce hydroelectric power, and an aluminium smelter, which are being developed respectively by the Government of Ghana through an independent public corporation, the Volta River Authority, and a company formed in Ghana by foreign private aluminium interests. Both are being assisted with loans by the Government of the United States and the United Kingdom and by the World Bank. About one-third of the output of power from the dam will be supplied to the smelter at an attractive rate.

The company has entered into a thirty-year Master Agreement with the Government under which each party obliges itself to build its part of the project. A special tax regime has been set up under which certain specified taxes only will be payable by the company. The rate at which income tax will be paid has been fixed for the entire period.

The company is also brought within the reliefs generally available for pioneer industries in their initial years of operation, which, however have been extended in several directions for its benefit. Other concessions which have been accorded the company include importation without restrictions of certain essential materials for the construction and operation of the smelter as well as any mines it may open up, permission to acquire bauxite concessions beyond the present statutory limits, and leases and services at favourable rentals. The loans for both parts of the

project have been exempted from Ghana income tax, and the loans to the Authority were exempted from stamp duty as well.

Exchange control authorisation for certain important transactions in connection with the financing and operation of the smelter including the accumulation and payment of foreign currency for vital expenses have been granted or assured to the company.

Each side has agreed to do everything necessary for securing and further assuring the right accorded to the other which on the Government's side has called for a large number of enactments and administrative orders to accomplish the concessions granted to the company. In addition, the Master Agreement and the loan and other agreements relating to the project have been legalised above the existing law of Ghana by a special Act of Parliament that automatically cures any defects in them.

The Agreement also contains important assurances against nationalization of the company or any of its assets including the interests of shareholders and creditors. There is a firm undertaking by the Government not to annul or modify the Agreement whether by legislation or administrative act, and any such amendment or modification is deemed to be nationalization which entails serious consequences. Even in the event of Ghana joining any larger political or economic unit, it undertakes to preserve the agreement and its schedules unimpaired.

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